Application No. 10/627,970
Amendment dated May 16, 2005
Reply to Office Action of February 17, 2005

Amendments To The Specification:

Please replace paragraph [0006] with the following amended paragraph:

It is therefore an aim of the present invention to provide a new blade inlet cooling flow deflector for controlling the split of air entering each internal cooling passages of a turbine blade.

Please replace paragraph [00011] with the following amended paragraph:

In accordance with a still further general aspect of the present invention, there is provided a method of supplying a coolant flow to an internally cooled turbine blade of the type having a root portion defining a coolant inlet, the root portion being received in a blade attachment slot defined in a rotor disc of a gas turbine engine, the method comprising the steps of: a) directing a swirl of coolant into said blade attachment slot, and b) pushing a low pressure region of the swirl of coolant away from said coolant inlet by deflecting the coolant inside the blade attachment slot while substantially preserving the ~~vertical~~ swirling nature of the coolant flow.

Please replace paragraph [00012] with the following amended paragraph:

In accordance with a still further general aspect of the present invention, there is provided a method of regulating the split of cooling air supplied to ~~a plurality of~~at least three cooling inlets leading to cooling passages defined inside at least one rotating airfoil in a gas turbine engine, the rotating airfoil being mounted to a rotary disc and cooperating therewith to form an air cavity therebetween, the air cavity having an entrance for admitting cooling air thereto, a downstream end at an end of the cavity opposite the entrance, and a sidewall extending radially along a disc radial axis and axially between the entrance and the downstream end, the inlets communicating with the air cavity and arranged in an array extending along the air cavity from a first of said inlet to a last of said inlets, the last inlet being closest to the cavity downstream end, the method comprising the steps of: a) rotating the rotary disc with the at least one rotating airfoil mounted thereto; b) directing cooling air into the air cavity through the entrance and substantially along the sidewall towards the

PAGE 4/18 * RCVD AT 5/17/2005 3:47:15 PM [Eastern Daylight Time] * SVR:USPTO-EFXRF-1/1 * DNIS:8729306 * CSID:514 286 5474 * DURATION (mm-ss):05-16

downstream end; and c) at a position intermediate the entry and downstream end, directing air away from said sidewall towards at least one inlet upstream of the last inlet.

Please replace paragraph [00028] with the following amended paragraph:

The deflector 48 is preferably provided as a downwardly depending projection integrally cast with the blade 26. The deflector 48 projects downwardly from the blade undersurface 34 and is located upstream from the downstream end of channel 38 (i.e. the end defined by tab 39), at a position intermediate the entrance of channel 38 and this downstream end of channel 38, and preferably adjacent the inlet 41 of the first cooling passage 40 (i.e. the leading edge cooling passage). As shown in Fig. 4, the deflector 48 has a curved backing surface 50 adapted to matingly engage the sidewall 53a and the deflector 48 preferably extends generally normally from sidewall 53a in order to form a throat in the channel 38. The deflector 48 has a curved flow leading edge surface 51 over which the cooling air entering the channel 38 is deflected in a direction away from the sidewall 53a. It will be understood that, due to the relative movement between the rotating turbine disc and the supplied cooling air, cooling air entering channel 38 generally does so at an angle to sidewall 53a, and therefore tends to be redirected by sidewall 53a. This redirection tends to set up a swirl or vortical flow for the coolant air in chamber 38, as is also described in ~~European Patent Application EP 1 251 243~~U.S. Patent Application Publication 2004/0115054 filed by Balland et al., the contents of which is hereby fully incorporated by reference into this description. Sidewall 53a is the sidewall which is downstream of the opposing sidewall 53 relative to the flow of coolant air entering the chamber 38 - i.e. sidewall 53a is the one which first meets the coolant flow entering the chamber.

Please replace paragraph [00029] with the following amended paragraph:

In use, a flow of cooling air entering the channel 38 has a tendency to flow to the side of the channel 38 corresponding to the pressure side of the blade 26, by reason of the direction and speed of rotation of the disc relative to the cooling air supply. Thus, as air enters air channel 38, it is redirected by the sidewall 53 corresponding to the pressure side of the blade 26 (indicated by reference numeral 53a in the Figures) and thereby guided towards the downstream end of the cavity. As described in the Background above, this asymmetrical

entrance of cooling air into channel 38 tends to cause an undesirable vortex in the prior art which can lead to unbalanced air flows into the array of cooling inlets in the blade. In the present invention, however, by providing the deflector 48 on the pressure side sidewall 53a, the cooling air flow is not directly split but rather deflected away from sidewall 53a and towards the cooling holes, which are typically aligned generally along a central axis of the channel 38. Preferably, the angle of at least a portion of the defector 48, such as the leading edge 51 thereof is acute relative to, and facing upstream into, the direction of the cooling flow entering the channel 38, so as to thereby smoothly guide the flow away from sidewall 53a and generally towards the other sidewall 53. Referring to Figures 7A and 7B, most preferably, the deflector 48 is adapted to guide the cooling air flow towards at least one inlet upstream of the last inlet 45 (i.e. one or more of inlets 41 and 43), to thereby balance the cooling flows between the plurality of inlets as desired. (Relative arrow size in Figure 7B is intended to represent the relative size of the main cooling flow components entering the inlets.) The designer may adjust the position and configuration of deflector 48 to achieve the designed balance between the flows entering inlets 41, 43 and 45. The centre of the vortex, which is a low pressure region and which is in a position corresponding with the location of an intermediate inlet in the prior art of the type depicted in Figs 6A-6C, is with the present invention "pushed" generally away from the air cooling inlets 41, 43 and 45 and weakened so that the cooling air may enter the blade 26 with minimal pressure losses. The deflector also pushes the airflow towards the inlets themselves, preferably so that no inlet location corresponds to a vortex-generated low pressure region. By so appropriately modifying the structure of the vortex, as opposed of breaking it, the cooling air can flow more directly and smoothly into the blade 26. In this way, coolant pressure losses can be minimized, particularly at the leading edge cooling passage 40. This prevents having to increase the pressure at which the cooling air is supplied to the blade cooling entry channel 38, and permits a more even distribution between cooling passages.

Please replace paragraph [00030] with the following amended paragraph:

As can be seen from arrows 49 in Fig. 3, the deflector 48 is preferably aerodynamically shaped and positioned to redirect the flow travelling along sidewall 53a inside the blade cooling entry channel 38 in such a way as to redirect the flow more towards

the forward passages 40 and 42. More particularly, as mentioned above, the deflector 48 preferably has an inclined surface 51, which deflects a portion of the incoming air directly into the leading edge passage 40 and the passage 42, to thereby permit the flows entering 41, 43 and 45 to be balanced as desired. According to the embodiment in Figures 7A and 7B, the leading edge 51 is planar and projects laterally outwardly from the sidewall 53a. However, it is understood that the leading edge 51 could be curved in any desired shape as well, as shown in Figure 8A. In fact, the deflector 48 may adopt various configurations depending on the number of inlets, the position and the size of the inlets, and the profile of the coolant flow entering the channel 38, as discussed further below. The role of the deflector 48 is to improve the pressure field distribution at the root of the blade cooling passages 40, 42 and 44 by changing the vortex structure of the flow so that the low pressure region associated therewith be as far as possible from the coolant inlets 41, 43 and 45. The deflector 48 causes the cooling air flow to swirl in at least a pair of smaller counter-rotating vortices.